

...working with industry to develop and apply technology, measurements and standards

NIST Research to Ensure the Integrity of Pipeline Facilities

**Dr. Carol Handwerker
Metallurgy Division
Materials Science and Engineering Laboratory**

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Extreme Exposure Conditions

- Recent unfortunate events suggest that pipelines may be subjected to:
 - **High Velocity Impact**
 - **Explosions**
 - **Fires**
 - **Fires followed by Detonations**
- What is appropriate research to predict pipeline behavior and assure integrity?

Research at NIST Relevant to Pipeline Integrity

- **Impact by projectiles etc.**
 - High rate/dynamic Stress-Strain Behavior of Linepipe Steels
 - High rate/dynamic Behavior of Projectile Materials
- **Explosions**
 - High rate/dynamic Stress-Strain Behavior of Linepipe Steels
 - Dynamic Toughness of Linepipe Steels

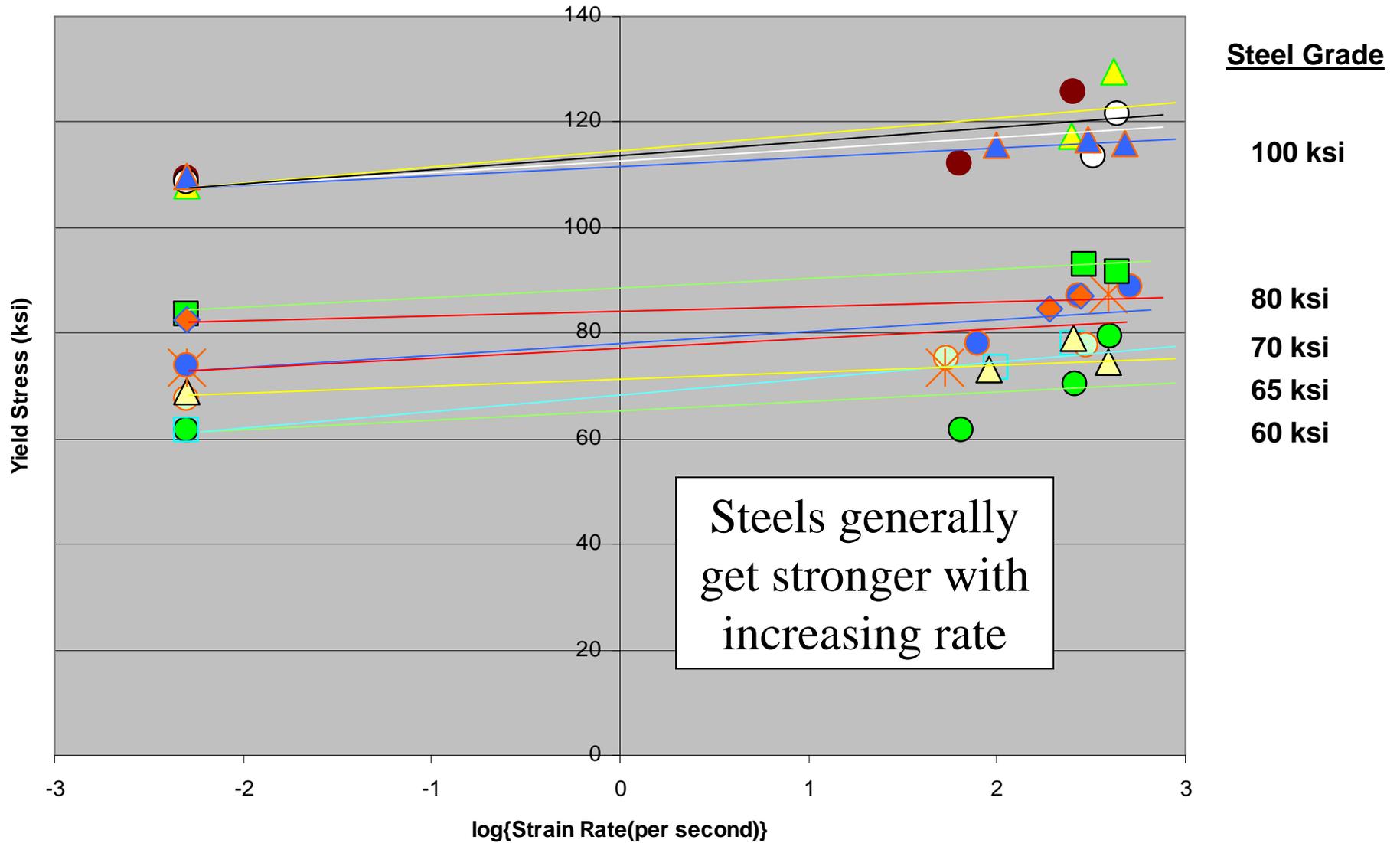
Research at NIST Relevant to Pipeline Integrity (cont.)

- Fires
 - High temperature mechanical properties of linepipe steels
 - Stress-strain behavior
 - Short term time-dependent (creep) behavior
- Fires and Detonations
 - All of the above and High Temperature Dynamic Toughness

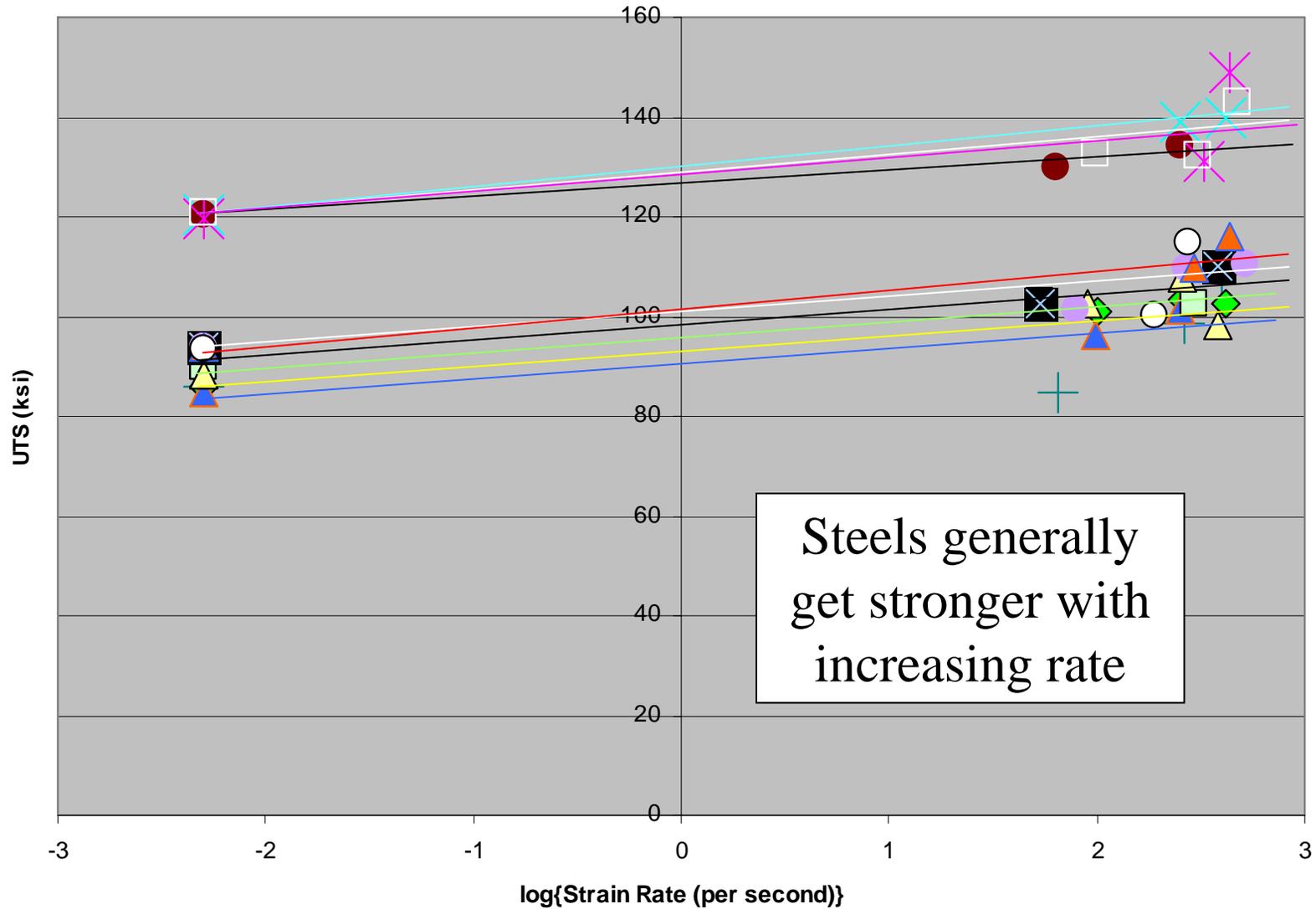
Recent Measurements at NIST

- High rate tensile tests at NIST(Boulder)
- High rate Kolsky Bar Experiments
- High temperature studies
- High rate/High Temp. Measurements

High rate tensile tests at NIST(Boulder)



High rate tensile tests at NIST(Boulder)



High Strain Rate Mechanical Properties

Conventional tensile vs Kolsky Bar (compression)

HSR tensile tests

- Yield and ultimate strength, ductility and workhardening behavior
- Strain rates up to 500 per second (50,000% elongation per second)
- Performed by NIST Boulder

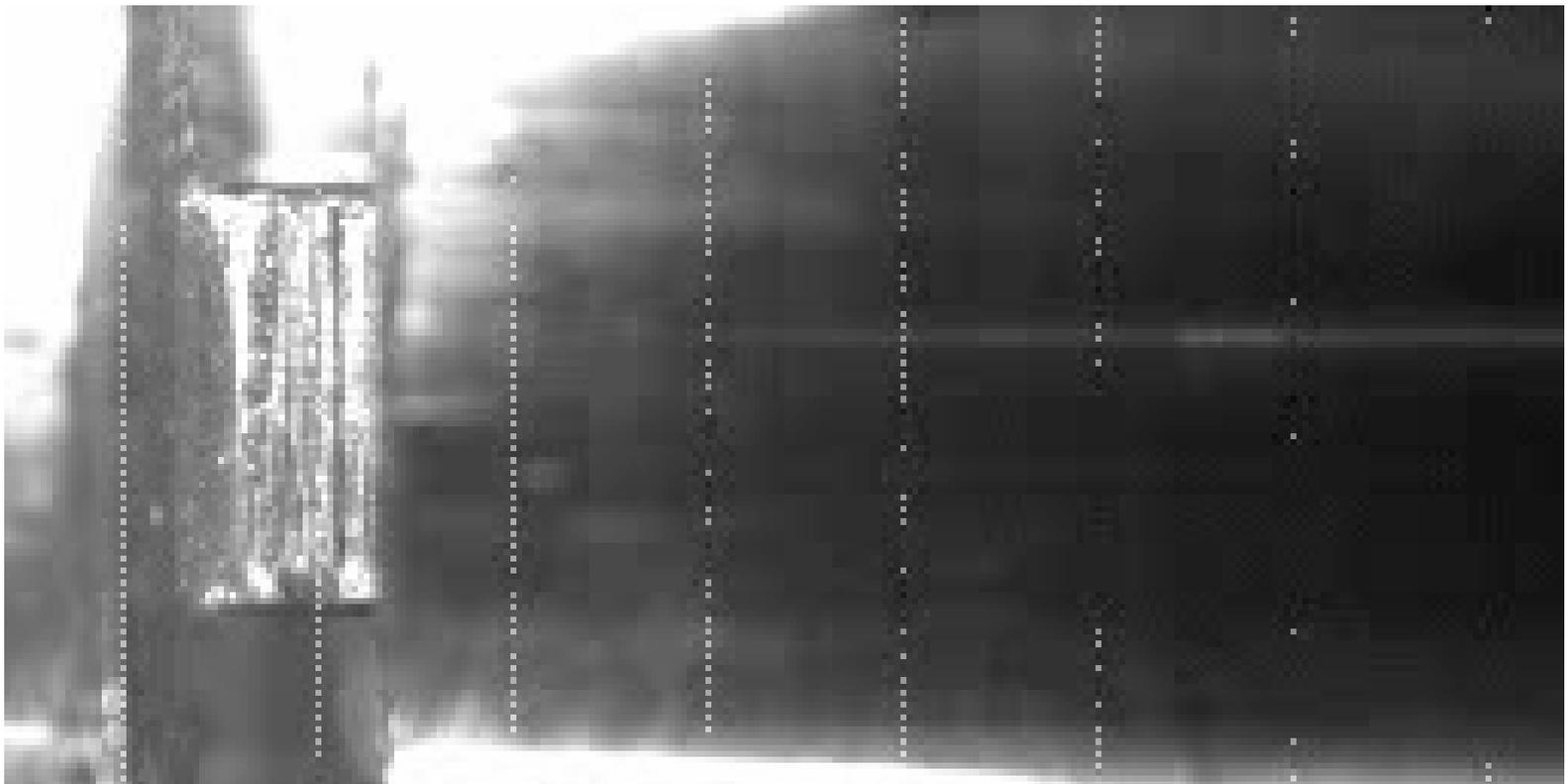
HSR compression tests

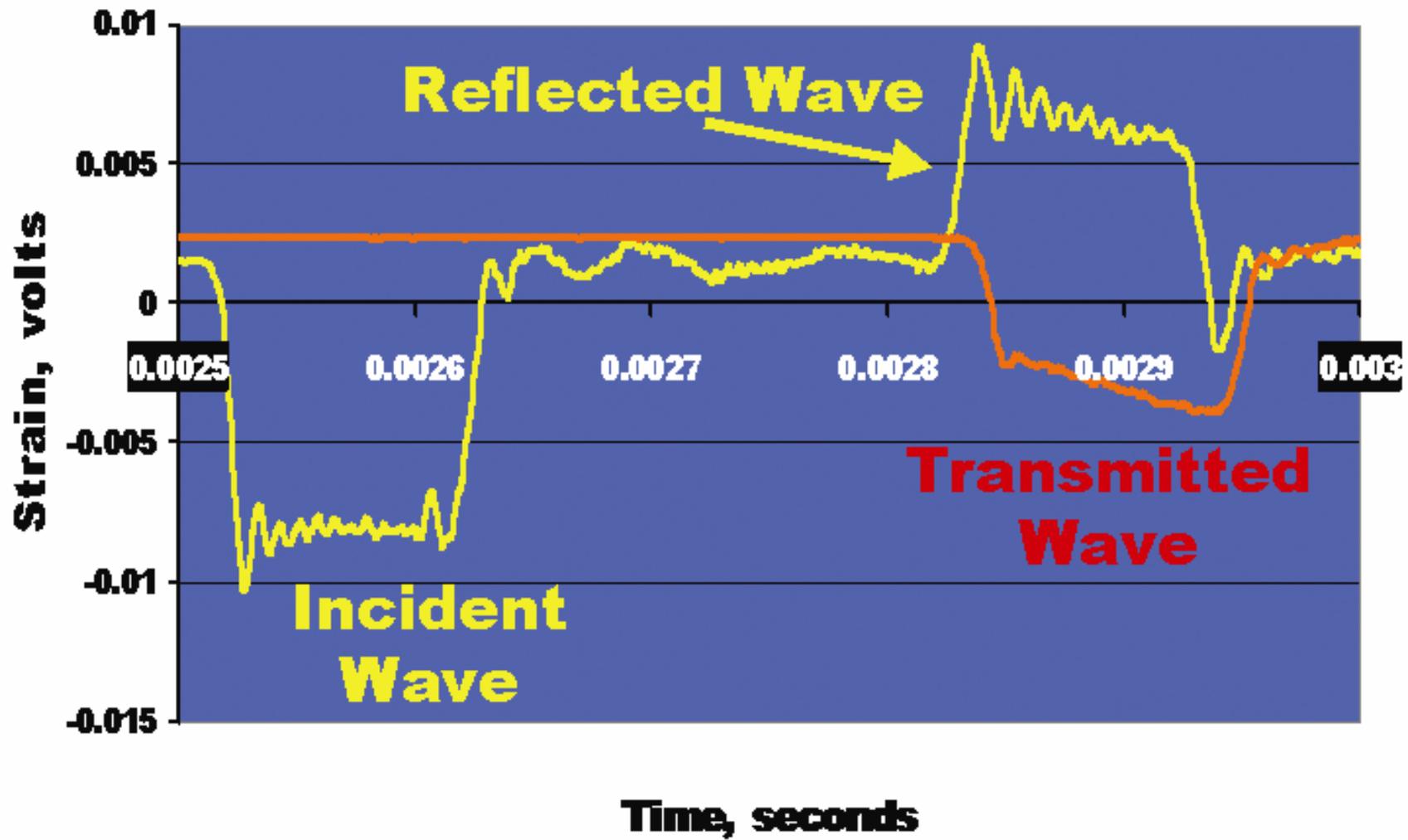
- Yield strength and workhardening behavior
- Strain rates from 500 per second to 5000 per second (500,000% elongation per second)
- Specialized Kolsky Bar equipment at NIST



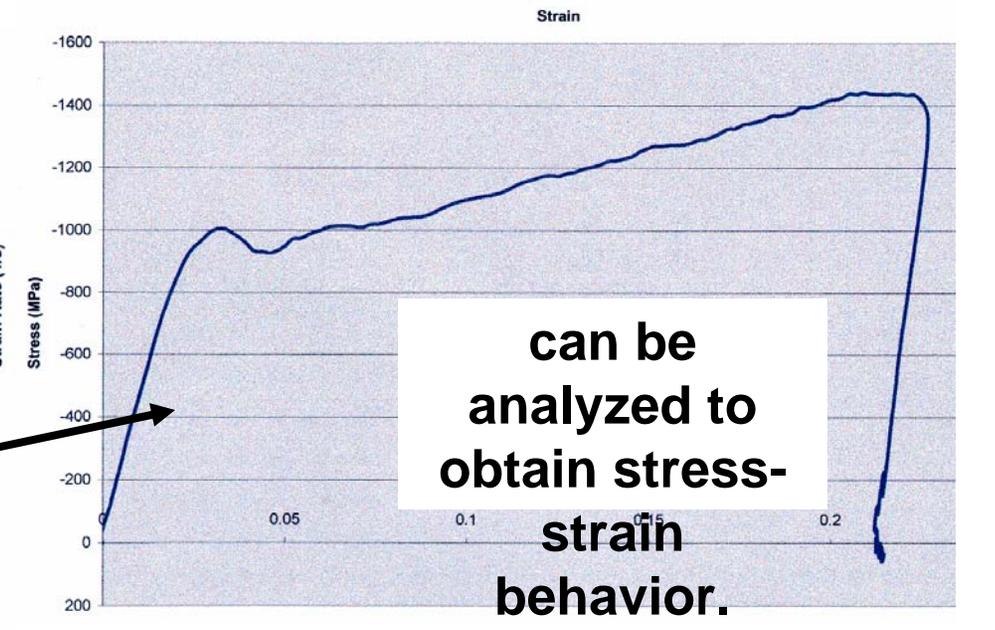
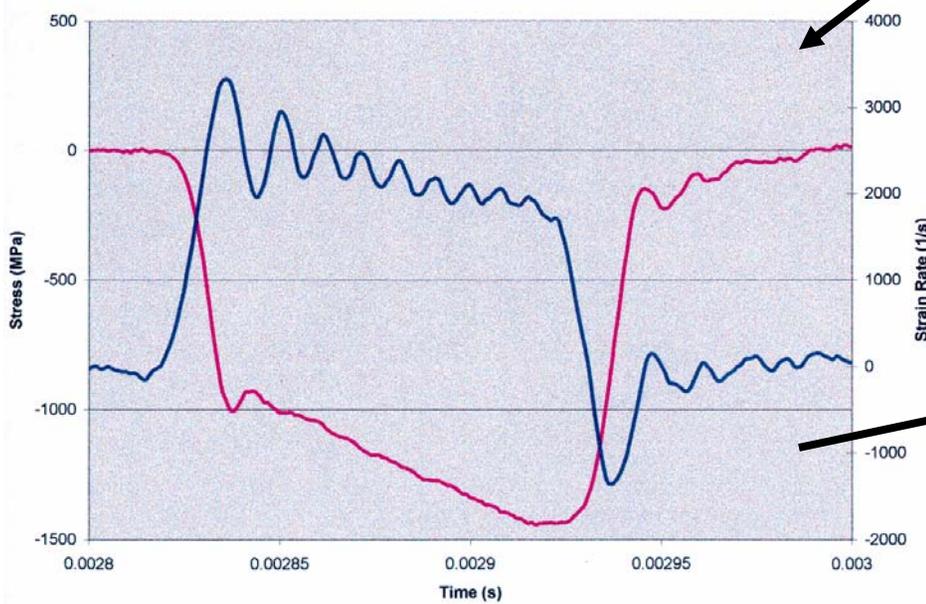
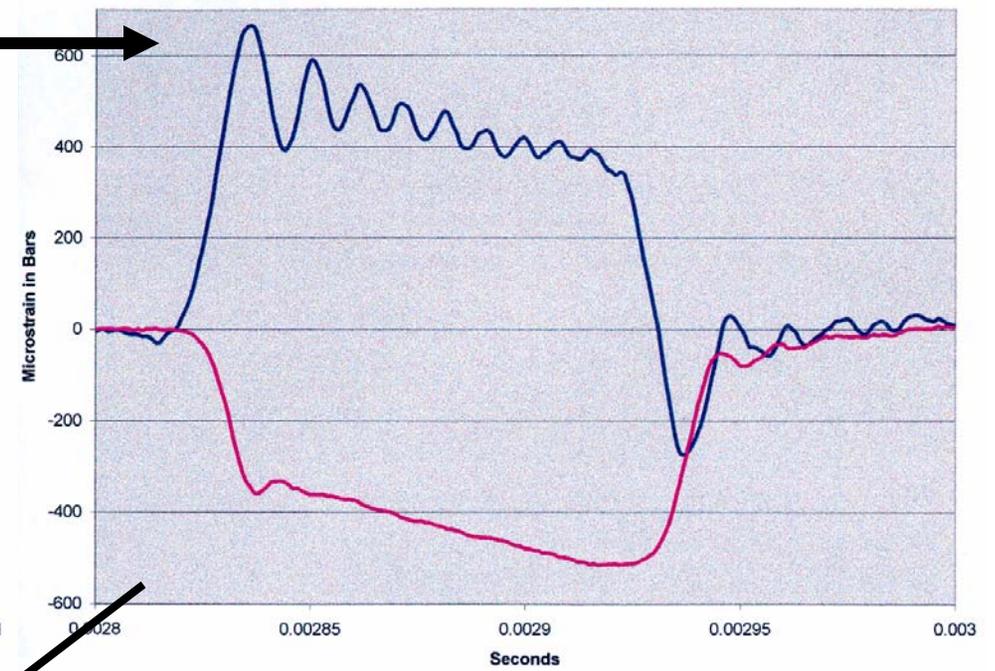
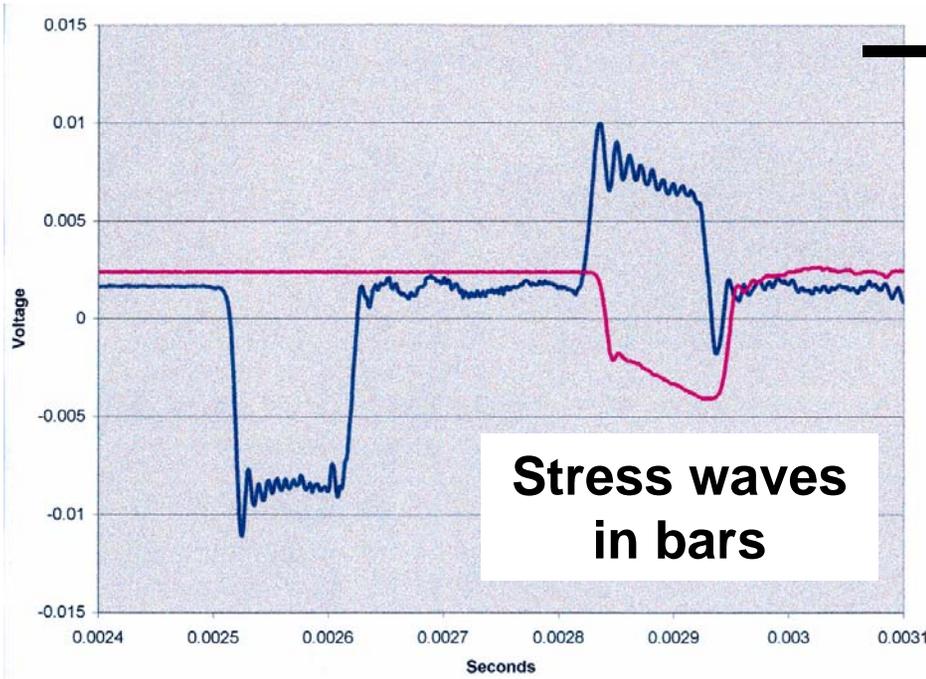
Kolsky Bar setup

Even higher rates can be studied
at NIST's Kolskey Bar Facility:

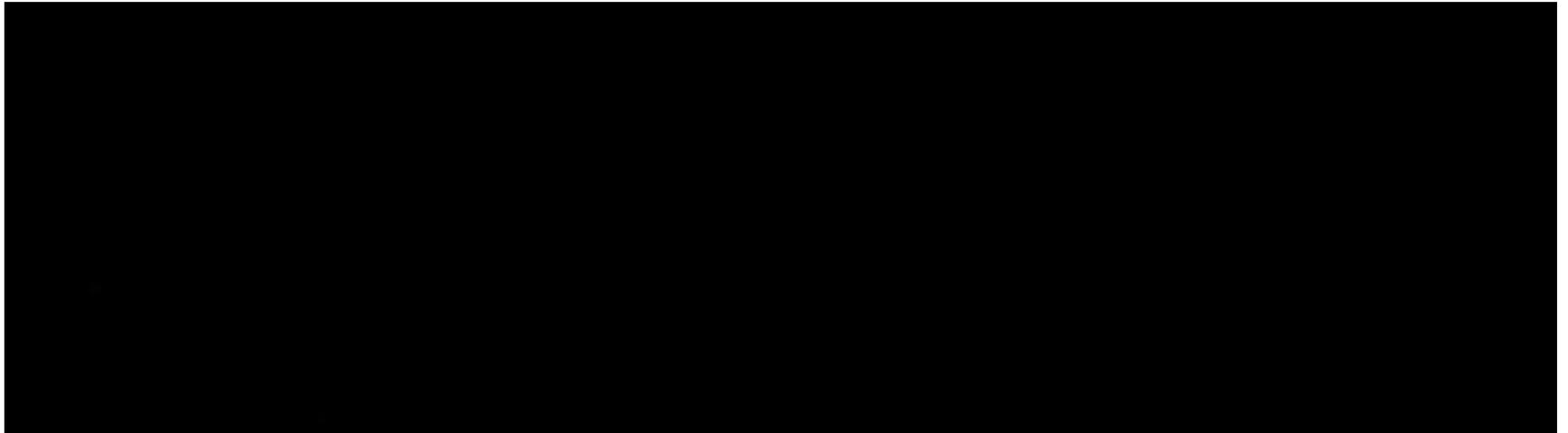




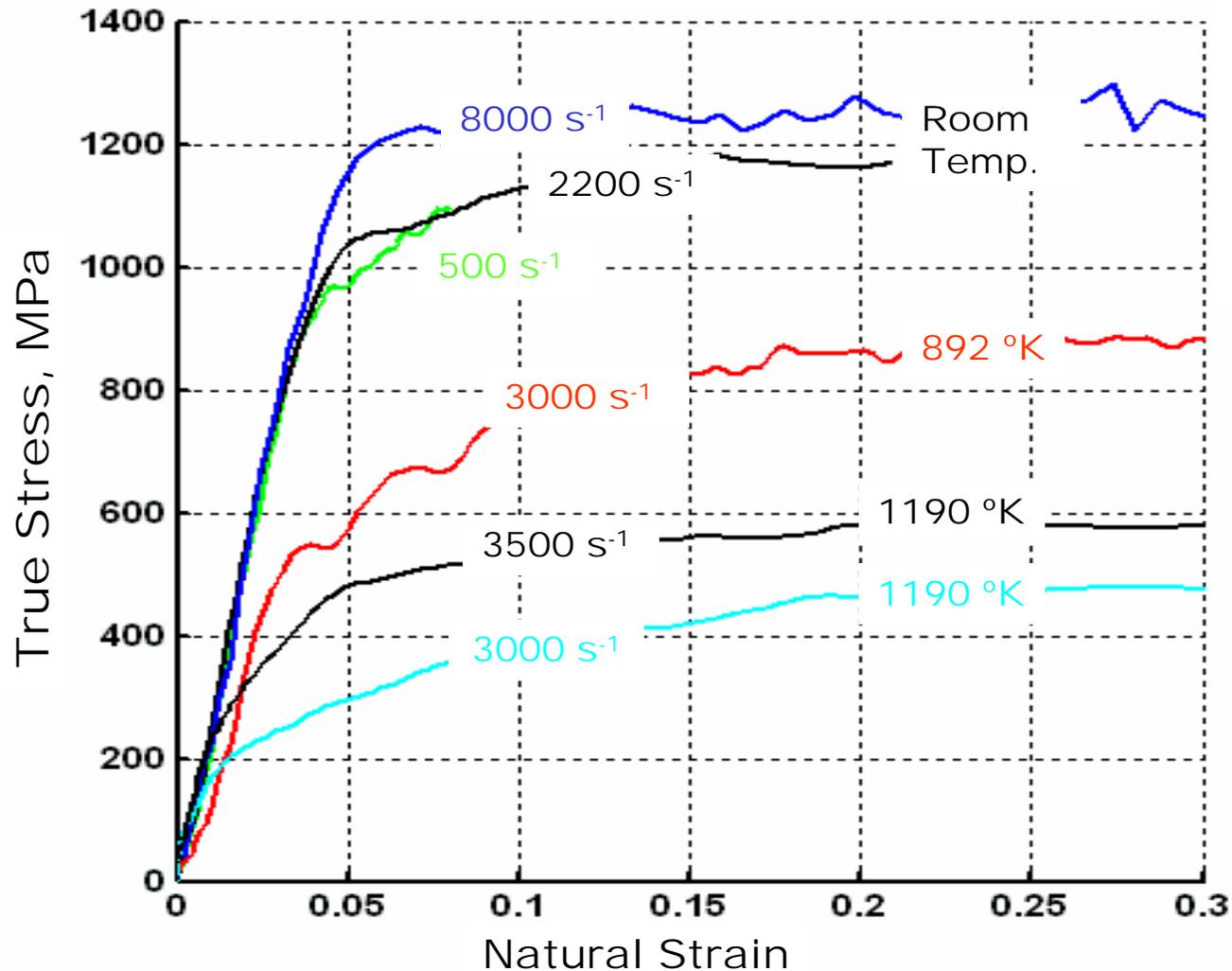
— Input Bar — Output Bar



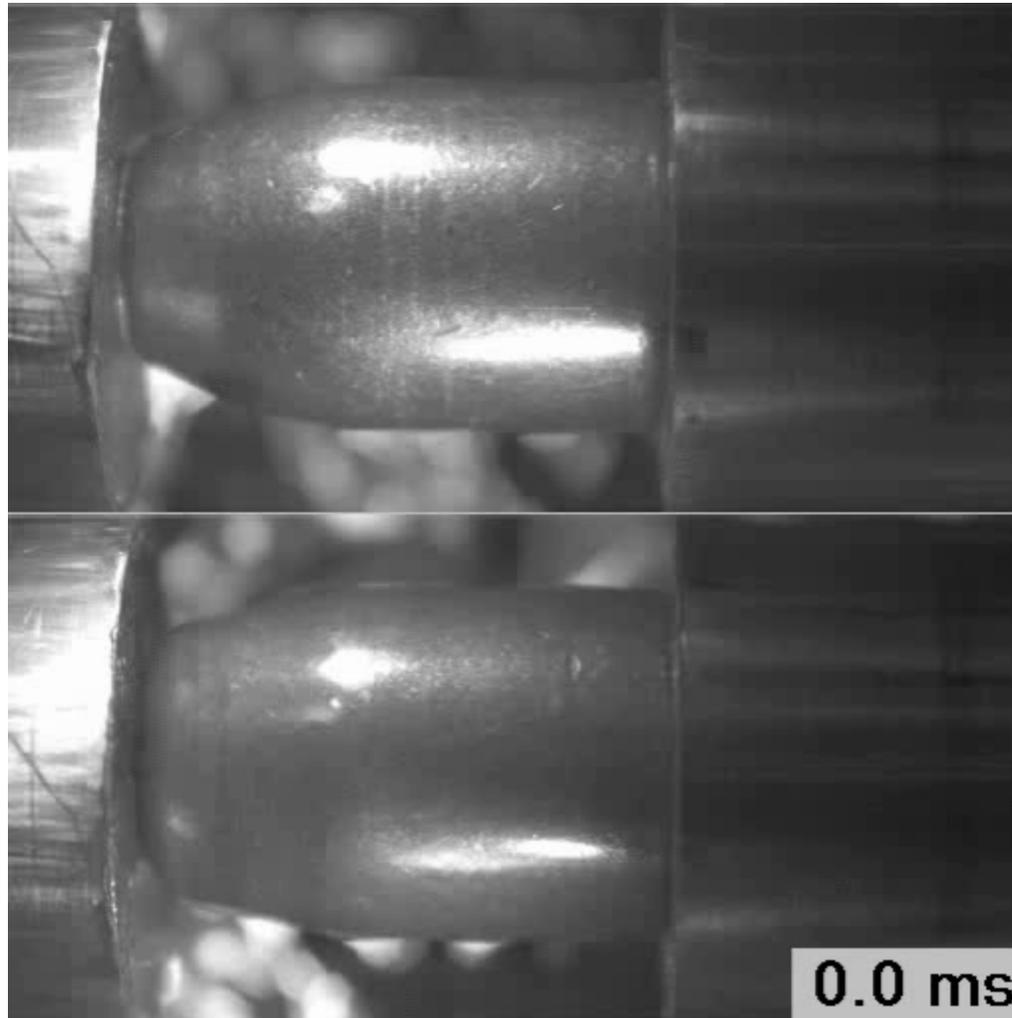
This facility includes a unique high heating rate (50,000 K/s) capability prior to impact:



Stress/Strain Curves can be obtained under extreme conditions that might jeopardize pipeline integrity.



The facility is also investigating behavior of projectiles that might be used to compromise integrity.



Future Needs: To Assure Integrity or Fail-Safe Behavior

- Crack arrest toughness data
 - To predict catastrophic behavior
 - To determine safe and cost effective placement of crack arrestors
- NIST has developed databases of crack arrest toughness for
 - NRC pressure vessel steels
 - FRA tank car steels
 - Oil storage tank steel and others

NIST Pipeline Research Plans

- Develop crack arrest toughness database for high strength pipeline steels
- Develop physically based model for crack arrest toughness
- Investigate potential for increased integrity high strength pipeline steels